
Space Weather Technical Forecast

Issued on Sunday, 18 June 2023 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of R1/R2 Radio Blackouts throughout. Active fluence likely by end of Day 1.

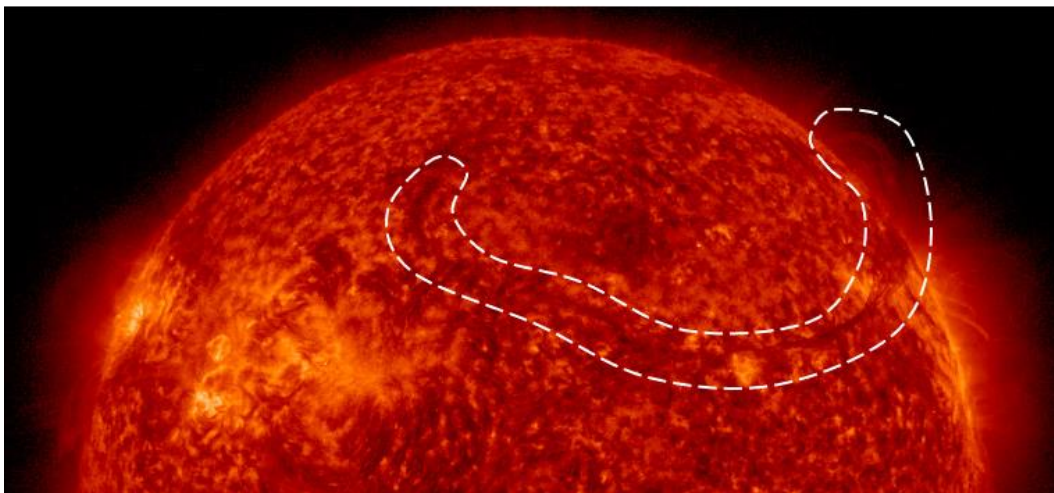
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours with a short duration M1.3 at 18/0031UTC, originating from AR3335 in the south-eastern quadrant.

There are currently ten sunspots on the visible disc. The largest and most magnetically complex is AR3335, which contains two small delta spots in its central portion. The second largest region is AR3333, although it appears to be relatively stable. Two regions have recently appeared on the eastern limb, one in the south (AR3339), currently a simple Hsx/Alpha, the other one in the north (currently unnumbered), a small Cro/Beta. AR3338, in the northeast quadrant, has now become relatively large, with small spots constantly growing and disappearing in its trailing portion. All other regions are small and magnetically simple.

A large prominence lifted off the sun during the evening UTC hours in the northwest quadrant, generating a couple of CMEs. The first one occurred around 17/1720UTC and is not considered to be Earth-directed. However the second one, which occurred around 17/2100UTC, clearly displays an Earth-directed component. It has been analysed and the results are still pending. However its velocity is not estimated to be fast, hence most likely to arrive at Earth on Day 4. Another CME was observed leaving the sun at 17/2350UTC, originating from a filament eruption in the centre south of the disc. This one has also been analysed and while the results are still pending, it is estimated to be much faster and may give a glancing blow at Earth on Day 2. Low confidence with timings until we obtain the results of the two analysis.

SDO/AIA 304 imagery from 17/1940UTC, showing the large prominence before it erupted



Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, was indicative of the waning influence from a fast solar wind stream. The solar wind speed saw a very gradual reducing trend, from approximately 560km/s down to around 380km/s. The solar wind density was below average, in single figures ppcc throughout. The IMF was weak throughout, its north-south component remaining unremarkable and between +3 and -4nT. The phi angle was mostly negative (towards the Sun) although it did become positive (away from the sun) for a little while. The net result of the above solar wind measures was Quiet (Kp0-2) with a provisional Kp '3' in the 00-03UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at Background levels.

High energy electron flux (greater than 2MeV), as observed by GOES16, rose from generally Moderate to High levels, with a peak of 1620 pfu at 17/1545UTC. The associated 24-hour fluence remained well below the Active threshold (1e8 integrated pfu) but displayed an increasing trend, with 6.12e7 integrated pfu observed at 18/0001UTC.

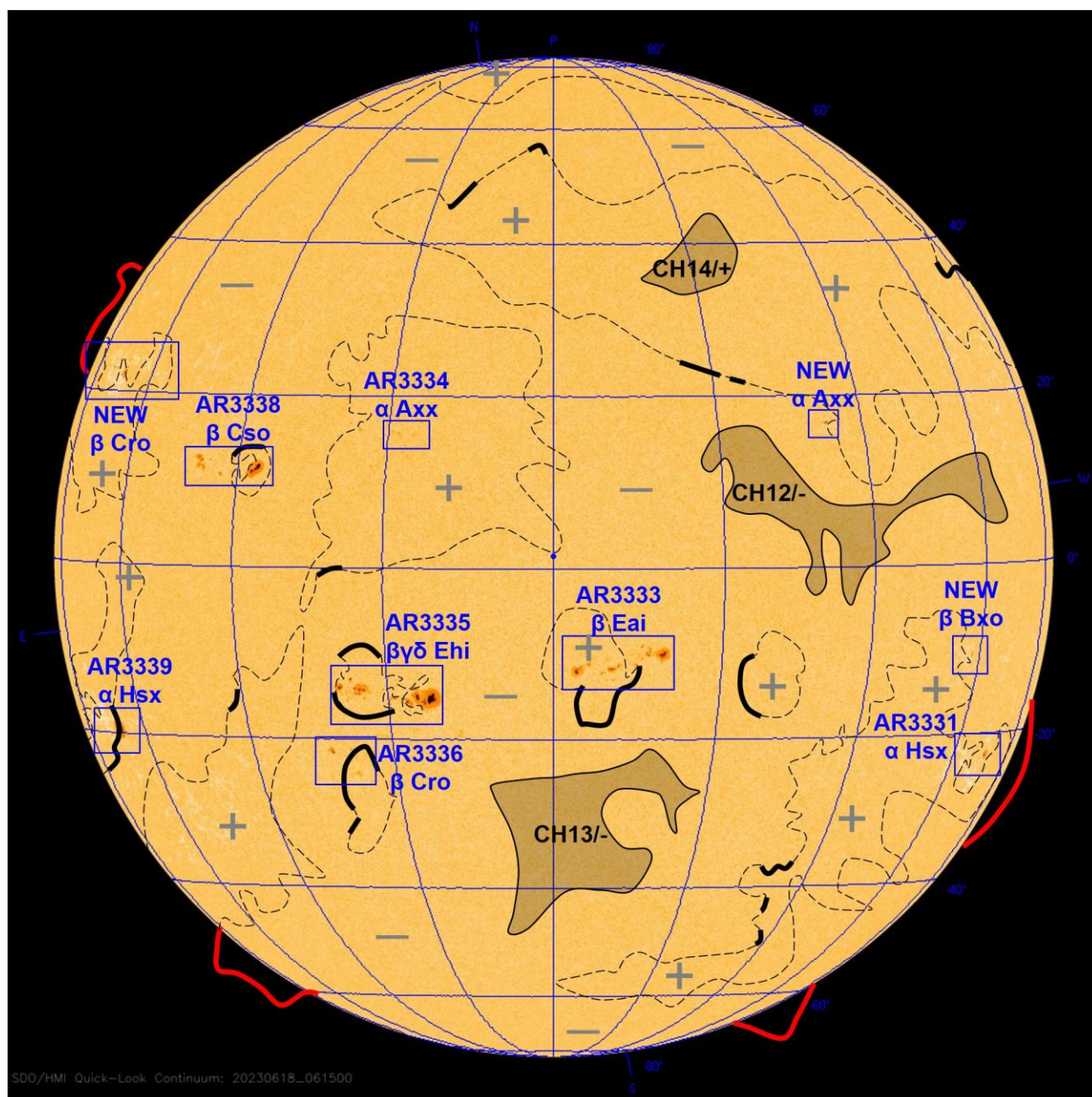
Four-Day Space Weather Forecast Summary

Solar Activity: Isolated Moderate activity remains Likely throughout the period, mainly from AR3335 and perhaps AR3333. With no significant regions leaving the disc in the coming four day, solar activity levels should remain unchanged. They may even increase given the bright flux regions observed in STEREO A and SDO imagery, indicating the potential for further regions to emerge from the far side.

Solar Wind / Geomagnetic Activity: Several CMEs were observed in coronagraph imagery. These have been analysed and although the results are not yet known, it is estimated that there is a chance of a glancing blow over the next few days. Geomagnetic activity is expected to be mostly Quiet with a slight chance of Unsettled intervals on Day 1 (18 June). However some magnetic storms are possible late on Day 2 (19 June - G3/ Strong Storm) and Day 3 (20 June - G2/Moderate Storm). Activity mostly Unsettled to Active on Day 4 (21 June). Very low confidence though.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, though a very Slight Chance of enhancement throughout given the current configuration of front-sided sunspot groups. High energy electron flux (greater than 2MeV) has been revised to show a likely sharper and greater increase in magnitude, probably odds-on for exceedance of Active 24-hour fluence by day 1 (18 June).

Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A large prominence lifted off the sun during the evening UTC hours in the northwest quadrant, generating a couple of CMEs. The first one occurred around 17/1720UTC and is not considered to be Earth-directed. However the second one, which occurred around 17/2100UTC, clearly displays an Earth-directed component. The results of the analysis are not yet known but its impact should be limited to a couple of Active intervals (Kp 4) given its estimated velocity, most likely on Day 4 (21 June). We are also awaiting results for another CME candidate. While the bulk of the ejecta is estimated to miss Earth to the south, it may give a glancing blow on Day 2 (19 June) with a chance of G3/Strong Storms although confidence is low at this stage.

On the coronal hole side of things we are now under the waning influence of the fast speed stream associated with CH12/-. As such, geomagnetic activity should remain mostly Quiet with a slight chance of Unsettled intervals. There may be slight enhancements to the solar wind speed over the coming days, due to a possible connection with either CH13 (southern hemisphere) or CH14 (northern hemisphere), but geomagnetic activity should not exceed Unsettled and Active levels given their relatively small size and based on the lack of evidence from the previous rotation. MOSWOC Enlil's handling of the current fast wind is reasonable, perhaps slightly underdone by 50km/s but improved versus recent runs, and the gradual decline from here is accepted as good guidance.

All things considered and pending the results of the CME analysis, geomagnetic activity is expected to be mostly Quiet with a slight chance of Unsettled intervals on Day 1 (18 June). Some magnetic storms are possible late on Day 2 (19 June - G3/ Strong Storm) and Day 3 (20 June - G2/Moderate Storm). Activity mostly Unsettled to Active on Day 4 (21 June). Very low confidence though.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	30	10	5
Strong	G3	No	1	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Pending results of the analysis.



Radio Blackouts - X-Ray Flares:

There are currently ten sunspots on the visible disc. The largest and most magnetically complex is AR3335, which contains two small delta spots in its central portion. The second largest region is AR3333, although it appears to be relatively stable. Two regions have recently appeared on the eastern limb, one in the south (AR3339), currently a simple Hsx/Alpha, the other one in the north (currently unnumbered), a small Cro/Beta. AR3338, in the northeast quadrant, has now become relatively large, with small spots constantly growing and disappearing in its trailing portion. All other regions are small and magnetically simple.

With no significant regions leaving the disc in the coming four day, solar activity levels should remain the same. They may even increase given the bright flux regions being observed in STEREO A and SDO imagery, indicating the potential for further regions to emerge from the far side. As there is not yet significant activity from over the east limb, flare probabilities are kept flat until these regions become visible and can be analysed. All things considered, isolated Moderate activity remains Likely throughout the period, mainly from AR3335 and perhaps AR3333.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest Solar Activity, as observed from GOES-16

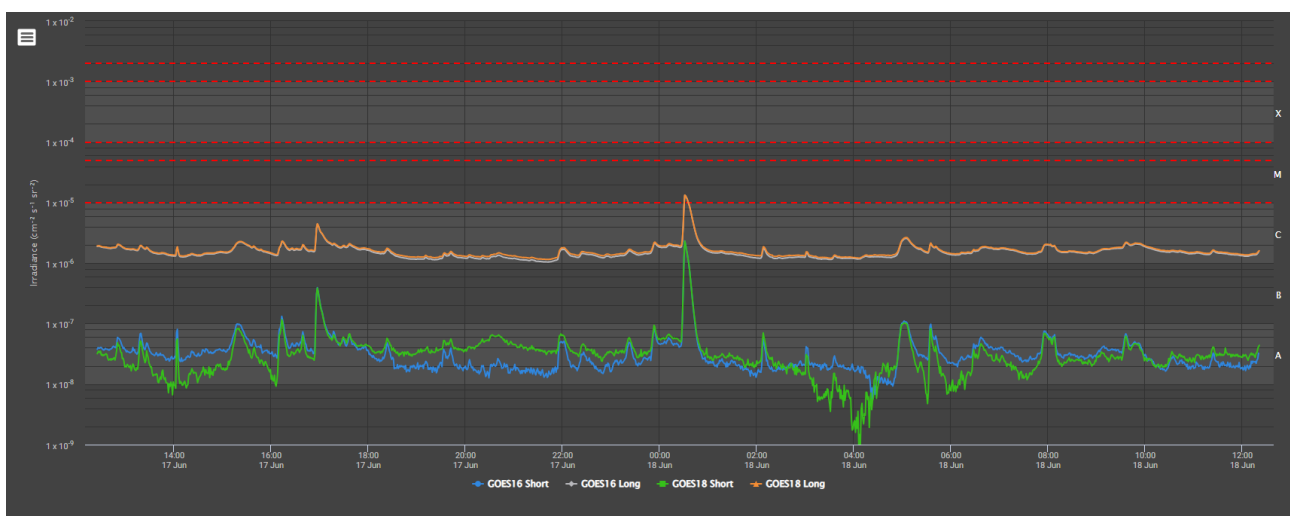
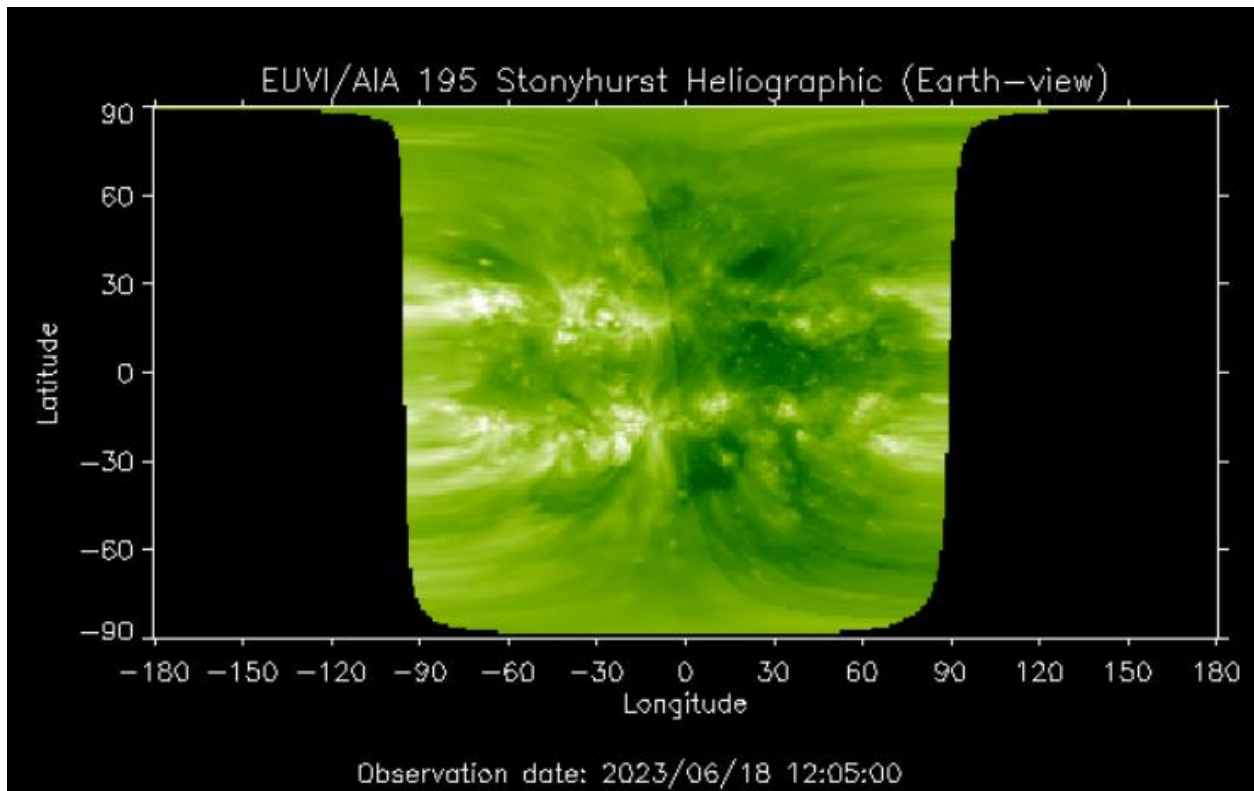


Figure 3: Latest EUVI / AIA 195 Å Stonyhurst Heliographic imagery, showing bright flux regions in the far East (left)



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is expected to remain at background levels. Slight chance of S1 given the sunspot groups on disc, although most of these are currently located in the eastern hemisphere and not in a geo-effective location.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) is expected to Moderate to High levels throughout the period. The unexpectedly potent fast wind emanating from CH12 likely to provide the impetus for at least diurnal peaks within High flux. This may mean that 24-hour integrated fluence could rise above active levels as early as day 1 (18 June), as the effects of fast wind from CH12 continues to wane, allowing the charged Van Allen belt to recover to register fully at GOES16. The forecast is now for a significant upturn in flux and fluence throughout the period, with exceedance of Active likely by day 1 (18 June).

MOSWOC REFM is showing a forecast trend in excess of that proposed by persistence, and this appears realistic, even if the exact timings are lower confidence.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	90	90	80	70
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	5	5	5	5

Figure 4: Latest REFM output, showing a slight rising trend towards Active levels on Days 1 & 2

